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FUNGOUS DISEASES OF THE CRANBERRY.

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BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., February 24, 1905.

SIR: I have the honor to transmit herewith the manuscript of an article on the Fungous Diseases of the Cranberry, and recommend its publication as a Farmers' Bulletin.

This paper was written by Mr. C. L. Shear, Pathologist in the Office of Vegetable Pathological and Physiological Investigations of this Bureau, and was submitted by Mr. A. F. Woods, Pathologist and Physiologist, with a view to publication.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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FUNGOUS DISEASES OF THE CRANBERRY.[a]

INTRODUCTION.

The cranberry (*Vaccinium macrocarpum*) has been in cultivation in this country for about three-quarters of a century. Some cranberry meadows have been bearing fruit for forty years or more without having been reset. This long-continued growth on the same land and under the same conditions has favored the development and spread of certain fungous diseases which are little known among the wild cranberries. These diseases are apparently spreading and assuming more economic importance each year. The greatest injury from such causes occurs on the New Jersey cranberry bogs. The New England meadows are affected to some extent, but western growers have comparatively little trouble from diseases of this kind.

DISEASES.

Only four of the diseases thus far found attacking the cranberry cause sufficient injury to need consideration here. These are what are popularly called, among growers, cranberry "blast," cranberry "scald," the cranberry rot, and anthracnose. Cranberry blast and scald are really but different effects produced by the same parasitic fungus.

CRANBERRY BLAST.

Cranberry blast is a name given to that form of the disease which attacks the very young fruits as soon as the blossoms fall. It causes

[a] The investigations by the Department of Agriculture of the fungous diseases of the cranberry were undertaken at the request of the American Cranberry Growers' Association and the New Jersey Experiment Station.

The results of the technical investigations of the Department upon this subject have not yet been published. The practical success attained in the efforts to control these diseases, however, is of such importance that the methods should be made known to the cranberry growers without delay in order that they may avail themselves of the remedy.—A. F. Woods, *Pathologist and Physiologist.*

the fruit to shrivel up, become black, and finally become covered with one of the spore-producing forms of the fungus, which is a species of *Guignardia*, very closely related to the species which produces the black-rot of the grape. The spores produced upon these young berries are the probable source of infection of most of the other fruit. This fungus, which is represented in its various forms in the accompanying figures, produces two kinds of fruit, or, in other words, passes through two stages of development. The earliest stage, called the pycnidial form, produces its spores in small black spherical receptacles, as shown in figure 1. The spores are furnished with an appendage at the end, as shown in figure 2. This fruiting form of the fungus is the most abundant, and it is probably from this source that most of the leaves and fruits are infected. The second stage in the development of the fungus is that in which the spores are produced in sacs, as shown in figure 3. These are inclosed

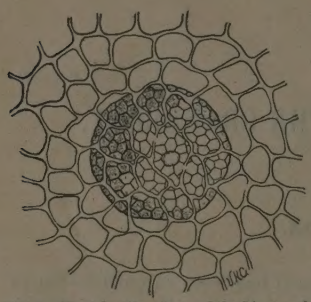

FIG. 1.—First fruiting form of the blast and scald fungus.

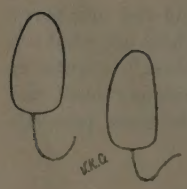

FIG. 2.—The spores of the first fruiting form, much magnified.

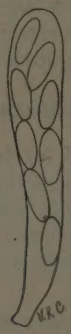

FIG. 3.—Sac with spores from the second fruiting form.

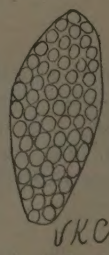

FIG. 4.—Single spore of the second fruiting form, much magnified.

in receptacles (perithecia), as in the other stage mentioned. Figure 4 represents a single spore from such a sac.

CRANBERRY SCALD.

The name "scald" originated as a result of the belief formerly prevalent among cranberry growers that the injury was due to the effect of the hot sun upon the berries when they were wet, thus producing what was regarded as a real scalding of the tissues of the fruit. Fruit

which has been overflowed for a half day or more during hot weather may be injured as a result, and the effect in many instances closely resembles that produced by the scald fungus. A microscopic examination of the berries shows at once the difference. In the berry which has been affected by being covered with water no fungous threads or filaments can be found, whereas in the case of the berry attacked by the scald fungus an abundance of such filaments may readily be observed in the pulp of the diseased berry. Only in the rarest instances does the scald fungus fruit on the berries after they have become half grown.

The disease first becomes noticeable as a small light-colored softened spot on the surface of the berry. This spot rapidly increases in circumference and finally envelops the whole fruit. Sometimes the diseased portion shows more or less distinct brownish zones. In other

FIG. 5.—Fruit showing scald and blast.

cases the zones are lacking and the whole fruit becomes very soft and has a light watery color. Figure 5 shows both forms of the disease. In many instances it is very difficult to tell from the external appearance only whether the disease is due to the scald fungus or the rot fungus.

CRANBERRY ROT.

Cranberry rot has until recently been confused with and attributed to the same cause as the scald. Its effect upon the berry is very similar to that of the scald fungus. It is produced, however, by a quite different species of parasite, though belonging to the same large group known as the "black fungi." In some cases where the fruit is in an

advanced stage of the disease, the presence of this fungus is indicated by the occurrence of irregular black blotches just beneath the skin of the diseased portion. The amount of injury from the rot is apparently not so great as that from the scald.

CRANBERRY ANTHRACNOSE.

Cranberry anthracnose seems to cause less damage in New Jersey than either of the other diseases just described, but it appears to be more common in Massachusetts and other New England cranberry meadows. It is caused by a species of *Glœosporium*, which closely resembles the species so injurious to the apple and other fruits. The effect of the fungus upon the fruit is very similar to that of the scald and rot, and can be distinguished from them with certainty only by careful examination or cultures made from the tissues of the diseased berries.

All these diseases attack not only the fruit but the leaves. They rarely produce their spores on the leaves until they have fallen or the plant has been entirely killed by the fungi or by some other cause.

REMEDIES AND TREATMENT.

Only preventive measures are available at present in combating these diseases. After the parasites have once entered the tissues of the plant they are practically beyond the reach of remedies. Hence, efforts must be devoted to protecting the plants and keeping them in the maximum condition of health and vigor, as in this condition they are most capable of resisting disease.

It has been frequently noticed that the plants on certain cranberry meadows and portions of meadows suffer much more from rot and scald than others. This is no doubt due in great part, in many cases at least, to the soil and water conditions under which the plants are growing. From personal observations and the experiences of growers it is the opinion of the writer that in the majority of cases the control of the water supply is the most important single factor.

Water supply.—Just what the best quantity of water is and the best way in which to distribute it can only be determined by study and experiment in each case, and will depend largely upon the nature of the soil and subsoil and the nature, contour, and drainage of the land. In general, it may be said that the water supply should be from a reservoir, if possible, and so controlled as to avoid any great fluctuations in the quantity supplied to the plants during the growing season. The cranberry is by nature a water-loving plant, and seems to suffer more frequently from a lack of water than from an excess.

Destruction of dead vines.—Another preventive measure of importance is the destruction of all dead vines and leaves. Frequently small areas of vines die, apparently from the attacks of the cranberry fungi. All

such vines should be pulled or cut and collected early in the spring, at least within two weeks after the water has been drawn from the bog, and burned. Vines which have been cut in raking bogs to prepare them for scooping should also be treated in the same manner. Such vines if not destroyed invariably produce the spores of the cranberry fungi in great quantities and are a fertile source of infection for the young leaves and fruit. Little is to be feared from the rotten berries which have reached maturity, as the fungi very rarely produce any spores on such berries.

Disease-resistant plants.—It is a matter of common observation among growers that some varieties rot or scald worse than others. Hence, in setting new bogs or replanting old ones the most hardy varieties should be used. By giving careful attention to the selection of disease-resistant plants for propagation, a practically immune variety can probably be eventually secured.

FUNGICIDES.

Several of the best fungicides have been tried for cranberry diseases, especially ammoniacal solution of copper carbonate, potassium sulphid, and Bordeaux mixture. The Bordeaux mixture has proved the most efficient of any used.

Effect of spraying.—The following results were obtained on carefully selected plots where from 75 to 100 per cent of the crop is lost each year from disease. Six plots of one-half acre each were sprayed four times during the season. Alternating with these plots were six others left unsprayed. According to actual counts made from September 8 to 13, 1904, of sound and diseased fruit on 35 yard-square plots, representing the average condition of the sprayed and unsprayed areas, it was found that the maximum of diseased fruit on any of the sprayed plots was 27.5 per cent as against 100 per cent, or a total loss, on the unsprayed plot. The minimum amount of disease on any sprayed plot was 13 per cent as against 89 per cent on the check plot. The average number of diseased berries on all the sprayed plots was 21.7 per cent, while on the unsprayed plots the average was 76.8 per cent. In addition to this there was a noticeably larger crop of fruit on the sprayed plots, and the plants looked more healthy and vigorous. With five applications instead of four it will no doubt be possible to reduce the amount of loss as low as 10 or 15 per cent. Satisfactory results from spraying can, however, be secured only by exercising great care and thoroughness in the preparation and application of the mixture.

Preparation of Bordeaux mixture.—Bordeaux mixture should be prepared as follows:

Copper sulphate (blue vitriol or bluestone)	pounds..	6
Unslaked stone lime	do....	4
Water	gallons..	50

To prepare the mixture most conveniently and economically, stock solutions of the ingredients should be made. Secure four barrels holding at least 50 gallons each, in addition to the barrel which is to be used for the spray pump. Place 100 pounds of good fresh stone lime in one barrel and slake the lime by adding water slowly, allowing the lime to crack and crumble. After the lime has been thoroughly slaked, add sufficient water to fill the barrel. When the whole is thoroughly mixed, as it should be before it is used, it will contain 2 pounds of lime to each gallon.

To prepare the stock solution of copper sulphate place 100 pounds of copper sulphate in a stout, coarse sack and suspend it in another barrel, which should be filled with water. The bluestone will all be dissolved in a day or two if placed as near the top of the barrel as possible. Never place the copper sulphate in the barrel loose, as it will take a much longer time to dissolve and will require much stirring. Each gallon of this solution will now contain 2 pounds of copper sulphate.

Make two half-barrels by sawing one of the 50-gallon barrels through the middle, and put 2 gallons of the stock lime (that is, 4 pounds) in one barrel and add sufficient water to make about 22 gallons. Stir this well to make a thorough mixture of the lime. Put 3 gallons of the stock copper sulphate solution (that is, 6 pounds) in the other half barrel and add enough water to make about 22 gallons. Two men with pails can now pour the two solutions together simultaneously into a barrel, as shown in figure 6, and then stir the whole thoroughly with a wooden paddle.

FIG 6.—Pouring together lime and bluestone solutions.

If desired, these stock solutions may be prepared by using only 50 pounds of lime and 50 pounds of bluestone in each barrel. If prepared in this way, the solutions would contain 1 pound to each gallon, and 4 gallons of lime and 6 of bluestone would be necessary for a 50-gallon barrel of Bordeaux mixture.

Soap for use with Bordeaux mixture.—To complete the mixture for effective use in treating cranberry diseases, it is necessary to add something to cause it to spread evenly and adhere to the foliage and fruit, whose smooth, glossy surface causes the plain Bordeaux mixture to

either collect in drops or run off entirely. Several soaps have been tried for this purpose, of which resin-fishoil soap has proved the best. This is prepared as follows:

Resin	pounds	5
Potash lye, such as is ordinarily sold for washing purposes	pound	1
Fish oil	pint	1
Water	gallons	5

Dissolve the resin with the oil in a large iron kettle. Let this cool somewhat and then add the potash, slowly stirring the mixture at the same time and watching it carefully to avoid its boiling over. Then add a part of the 5 gallons of water and continue boiling until the mixture will dissolve in cold water. This will require about one hour, when the remainder of the water should be added slowly and the whole thoroughly stirred.

Making the soap.—This soap can be most quickly and conveniently made by using one of the various forms of feed cookers used by farmers for cooking feed, heating water for scalding hogs, etc. These are quickly heated and have a reservoir or kettle capacity of half a barrel or more. In this way a quantity of the soap may be prepared at one time and kept in stock for use as desired. Two gallons of this soap should be added to each 50 gallons of Bordeaux mixture, and the whole should then be strained into the pump barrel through a brass wire-cloth strainer. It is important that the mixture should be well strained, else there will be more or less trouble from the clogging of the spray nozzles. This soap is now being manufactured and placed on the market. If the thick commercial soap is used, 4 or 5 pounds should be diluted in 2 gallons of water and added to each 50 gallons of Bordeaux mixture.

FIG. 7.—Movable platform for use in preparing Bordeaux mixture.

Three forms of spraying outfits have been tried—the knapsack pump, the barrel and cart or wagon outfit, and a horsepower force pump. The knapsack pump, as illustrated in figure 9, is only adapted for use where small areas are to be sprayed, as the work can not be done rapidly enough. The most rapid method is the horsepower or other power force pump.

In actual experience, several objections to the use of the ordinary forms have been found. In the first place, it is impracticable or impossible in many cases to use a horse on the bogs on account of the soft and miry condition of the land. Where a horse can be used,

FIG. 9.—Spraying with a knapsack pump.

however, an ordinary horsepower pump does not satisfactorily cover the plants with the mixture. The vines are usually thick and more or less matted, covering the whole surface of the ground, so that it is necessary in order to cover as nearly as possible the surface of the leaves and berries to direct the spray against them from various directions and for a longer time than can be done with a constantly moving pump. The writer has been able to do the most satisfactory work by using a barrel and pump outfit, placing it in a low-bodied wagon, as shown in figure 11, in cases where a horse can be driven on the bog, or

on a handcart in other cases, as shown in figure 10. Such an outfit, fitted with two 20-foot hose, a 4-foot extension-rod attachment, and two Vermorel nozzles each, can be handled by three men, and a strip 50 feet wide can be sprayed at each trip across the bog.

FIG. 10.—A barrel and cart spraying outfit.

Number of sprayings necessary.—At least five applications of the Bordeaux mixture should be made during the season, and not more than fifteen days should in any case elapse between two applications. The first appli should be made early in June, the next the latter part when the blossoms are ready to open, and the third as

FIG. 11.—A barrel and wagon spraying outfit.

plants have passed the height of their blooming period. tion is a very important one, and if thoroughly and should prevent the blasting of the young fruit due to of the scald fungus. It is best to avoid possible inj

occur by spraying when the plants are in full bloom. The fifth application should not be made earlier than August 15, as it is extremely important that the berries be protected against infection at this time.

The fruit should be picked as early as practicable, in order to avoid infection, which may occur when the protection of the last application begins to be lost by the washing of rains. Do not spray immediately after a rain nor when dew is on the vines. In such cases the mixture becomes diluted and collects in drops instead of forming a film over the surface, as is desired.

COST OF TREATMENT.

eful estimates based upon the cost of material and applications can be made at the rate of four barix mixture per acre at each spraying at an expense of re, not counting the cost of the spraying apparatus. reduce the cost as much as possible and at the same time expedite the work, it is necessary to have materials and apparatus as conveniently arranged as possible. The stock solutions of lime and tone, as well as the resin-fishoil soap, should be prepared in kept near the area to be sprayed. All the materials mixture except the lime can be bought from a wholesale The cost of copper sulphate crystals in quantity should 8 cents per pound. The resin may be bought for about s per pound, the potash lye 10 cents per pound, and the fish bout 75 cents per gallon, or very much less when purchased in ntity. The manufactured soap can probably be purchased cheaper n it can be made by the cranberry grower.

SUMMARY.

he cranberry blast, scald, and rot are caused by parasitic fungi.
praying experiments have demonstrated that these diseases can ontrolled by a proper application of Bordeaux mixture.
make the mixture effective it must be carefully prepared and oughly applied, with the addition of resin-fishoil soap or some spreading and adhesive mixture. Careless or partial spraying rse than useless.
least five applications should be made during the season. No than fifteen days should elapse between the applicaapplication should not be made earlier than August 15.
y to use at least four barrels per acre at each spraying. vines must be thoroughly covered in order to protect them.
nd cart or barrel and wagon spraying outfit, with two of hose, has been found most satisfactory.
acre for spraying five times during the season should o the methods described here, exceed $15.

O